Asymptomatic malaria remains high among seasonal migrant workers depart to home from malarious areas and may cause a resurgence of malaria transmission at high lands of northwest Ethiopia: a cross-sectional study

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Research Article

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Asymptomatic malaria remains high among seasonal migrant workers depart to home from malarious areas and may cause a resurgence of malaria transmission at high lands of northwest Ethiopia: a cross-sectional study

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Abstract

Background: In Ethiopia, thousands of seasonal migrant workers used to travel from non-malaria or mild malaria transmission areas to malaria-endemic areas for seasonal farm activities. Most of these migrants are staying in the farm areas for land preparation, plowing, planting, weeding, and harvesting for a specific period and back to their living areas. However, there is limited evidence of how the seasonal migrant workers contribute to the transmission of malaria to new or less malaria transmission areas.

Methods: A cross-sectional study was conducted at the departure phase of seasonal migrant workers in the Metema district from September 2018 to October 2019. A total of 1208 seasonal migrant workers were interviewed during their departure from farm sites to their homes. Interviewed face to face interview was done using a pretested structured questionnaire. Moreover, blood samples were collected from each study participant for microscopic malaria parasite examination. The data were fitted with the logistic regression model to estimate the predictors' of malaria transmissions.

Results: At the departure to home, the prevalence of malaria among seasonal migrant workers was 17.5% (15.6-19.45%). About 71.80 % (177/212) of the cases were *Plasmodium falciparum,* and 28.20% (35/212) *Plasmodium vivax*. The majority of seasonal migrant workers (77.4%) were from rural residences and highlanders (55%). Most (55.4%) of the migrants have visited two and more farm sites during their stay at development corridors for harvesting activities. About 116 (54.7%) asymptomatic malaria cases were returning to Dembiya(21.7%), Chilaga(19.8%) and Metema(13.2%) districts.

Conclusion: This study focuses on the prevalence of asymptomatic malaria among seasonal migrant workers during the departure phase to home. The role of seasonal migrant workers in carrying and spreading malaria parasites, as well as challenging the country's malaria prevention and elimination efforts, could be enormous. Age, occupation, origin, the number of farm sites visited, and the frequency with which LLINs were used were all associated with an increased asymptomatic malaria prevalence in the study area. Tailored interventions for seasonal migrant workers could be in place by programmers, partners, and implementers to enhance malaria control and elimination.

Keywords: asymptomatic malaria, departure, seasonal migrant workers

Background

Malaria is continuing a global public health problem[1]. It is caused by Plasmodium parasites and in most cases, transmitted through the bites of female Anopheles mosquitoes. Among the 5 Plasmodium parasite species which cause malaria in humans, *P. falciparum* and *P. vivax* are widely distributed around the globe. In the WHO African region, Plasmodium falciparum is the most prevalent [2, 3].

Globally, between 2010 and 2018 successful decline of malaria incidence rate was documented, from 71 to 57 cases per 1000 population at risk[4]. However, after 2016 the success started slowing down and remains a major burden of disease [3]. In 2018, World Malaria Report indicated an estimation of 228 million malaria cases and 405,000 deaths globally. WHO African region shared 93% of all the cases and 94% of all deaths [5]. In Ethiopia, over 68% of the country's landmass is still malarious where 60% of the population is at risk of malaria infection [6-8]. In 2016, an estimated three million new malaria cases and five thousand deaths were reported [9] which showed 50% malaria incidence and mortality decline compared to the previous years [10]. This achievement was associated with improved coverage of LLINS, IRS, malaria diagnoses using RDT, and prompt treatment using ACT, and destruction of mosquito breeding sites using environmental management from 2005 up to 2015 [10]. However, malaria remains among the ten top leading causes of morbidity and mortality [11, 12]. Moreover, the country has not yet established robust surveillance and health management information system to monitor mortality and incidence rates of malaria [11].

Migration to countries and within countries is usually cyclical and seasonal [13]. In Asia and Africa, people are moving from country to country or within the country for economic purposes, mostly for agricultural activities [14]. Most agricultural farms are found in high malaria transmission areas and movement from malaria-free or low malaria areas to these areas puts migrants at risk of malaria infection [15]. This would result in a resurgence of malaria, outbreaks, the spread of malaria parasites and drug-resistant malaria parasites, and challenges of malaria prevention and elimination activities [16, 17]. Studies revealed the risk of confirmed malaria in the high land areas was up to 7 times higher in people who had a travel history to high malaria transmission areas than those who hadn't [18]. Moreover, studies were identified risk factors that increased exposure to malaria among seasonal migrants being a male [19], low education status and low knowledge of malaria prevention methods [17, 20, 21], sleeping outside the house and working at night, low treatment-seeking behavior [22, 23], and low access to and utilization of ITNs [24-26].

Studies have shown that population movement is closely linked to malaria spread, resurgence, and outbreaks [27-29] and countries have found migration as a key player in the reintroduction of malaria cases [30] and it has been posed challenges to the control and elimination of malaria [31, 32]. African countries were particularly affected by unrecognized migrants and were unable to continue with the malaria elimination program. As a result, following the renewal of the malaria elimination paradigm in recent times, the population movement has got recognition especially in countries that eliminated malaria and those which are moving to eliminate malaria and sustain malaria elimination[32].

In Ethiopia, most of the migration is seasonal or cyclical [25]. Seasonal migrant workers are key players either as active transmitters or passive acquirers. As active transmitters, they harbor the parasite due to their low level of immunity or non-immune for malaria and are at high risk to malaria infection and transmit the disease to areas of low or sporadic transmission and as passive acquirers, they are exposed to the disease through movement from one environment to another [30, 33, 34]. Moreover, it has been shown that seasonal and short-term migrant workers are more at risk of malaria infection and playing a central role in malaria transmission due to traveling to endemic areas with no immunity or partial immunity[27]. Health facility-based malaria studies revealed a high prevalence of malaria parasites among returnees from malaria-endemic areas [8, 24]. Therefore, seasonal migrant workers can reintroduce the parasite and initiate resurgence and an outbreak of malaria when they return to their permanent living home where it might be malaria receptive [32].

The magnitude of malaria in seasonal migrant workers during harvest time and their role in malaria transmission to new or low malaria transmission areas is less known. Therefore, this study assessed asymptomatic malaria prevalence and associated risk factors among seasonal migrant workers at departure return to home. The outcome of this study could provide valid information and insight that will bridge the knowledge gap for programmatic improvement of malaria prevention and control in Ethiopia tailored to seasonal migrant workers in particular.

Methods

Study area

The study was conducted in the Metema district of northwest Ethiopia (**Figure1**). It is one of the nine agricultural investment districts with a total permanent resident population of 154,618[35]. The district is sharing boundaries with three districts, Quara, West Armachio, and Chilga, and Sudan as well. The study area is lowland with an average altitude of 750m (500-1000m). The mean annual rainfall for the area ranges from about 850 to 1000mm. The district has 26 rural and three urban kebeles one district hospital, five health centers, and 26 health posts as well as private facilities: 47 clinics, 5 medium diagnostic laboratories, 14 drug vendors, 9 rural drug shops, and 21 legal traditional medical sectors[36].

Metema district is one of the seven agricultural investment areas receiving an estimated 120,000 seasonal migrant workers mainly from the Amhara region with various climatic zones: highland, midland, and lowland. These migrants are mostly engaged in farmland preparation/ farm site clearing, farming, weeding, and harvesting of Sesame, Sorghum, and Cotton products at their destination. Site clearing, farming, planting, and weeding take place from May to the second week of September. Harvesting of Sesame is from the end of September to December, major malaria transmission season following main rain season (June to September). Then few migrants will remain at distention from one month to six months to collect Sorghum and cotton.

Sample size, sampling, and data collection

Single population proportion was used to calculate the sample size with estimated proportion of 27.5% [37] and acceptable difference=3%, $\alpha = 5\%$ (95% confidence level), and 10% non-response rate. Therefore, a total 1256 sample size was determined**.** The response rate was 96% (1208).

Participants were identified at departure just after they completed the contractual agreement and left the farm sites to areas where they stayed for hours to few days until they got transport to their origin/home. Returnees were gathered in two towns, Delelo one and Delelo two, where they approached to identify the average flow of seasonal migrant workers to these towns and to identify the time when to get the majority of the study subjects. Registrations of migrants were done at the departure sites by data collectors daily and a random sampling collection method was employed. Data collection at the departure helps to understand the number of malaria parasites to be carried by seasonal migrant workers from farm sites to their origin or living home.

Data on sociodemographic characteristics and knowledge of malaria prevention methods were collected from the departure phase for malaria infection using a structured questionnaire. The questionnaire comprised independent predictors such as sociodemographic characteristics (sex, age, education, occupation, religion, ethnics, and salary), residence (urban, rural), origin/ homeland (highland, midland, lowland), and knowledge of malaria prevention methods. In this study, high land ("Dega") is defined as the origin or homeland of seasonal migrant workers where malaria transmission is low or free of malaria which situated between 2000 and 2500 m above sea level; midland ("Woina Dega") or highland fringes are geographic areas situated between 1500 and 2000 m above sea level and presented by both low and high malaria transmission, and lowland ("Kola") is presented by altitude less than 1500m above sea level where malaria transmission is intense [38].

Ten data collectors were involved in the data collection from the departure. All data collectors have three to five years of experience in malaria data collection in the area. The quality of data collection was monitored daily by three supervisors and the principal investigator.

Microscopic blood examination

Both thick and thin blood smears were prepared from each selected seasonal migrant worker following standard operating procedures [39]. Two drops of blood were collected on a clean microscopic slide. One drop was used to prepare a thick smear and the other was used to prepare a thin smear [40]. Finally, the slides were labeled with participant code and packed into slide porter after being air-dried [41]. All slides were transported to Metema Hospital located in Gendewuha town. The thin smear on each slide was fixed with absolute methanol and both thick and thin smears were stained with 10% Giemsa for 10 minutes and examined microscopically under a light microscope for malaria parasites. Parasite results were reported based on screening of 100 microscopic fields at x100 magnification. The initial thick film was classified as negative if no parasites were to be found after 500 white blood cells were counted. For quality assurance, 10% of positive slides were checked by a senior laboratory technician for species confirmation[42]. Accordingly, the conformation of species types and positive reports were checked and there was no discrepancy between the first microscopists and the senior laboratory technician who controlled the quality.

Variables of the study

Independent variables are socioeconomic, demographic, knowledge and practice of malaria and malaria prevention methods, and environmental factors. The presence or absence of malaria parasites was a dependent variable.

Data processing and analysis

Before entering the completed data, a database template was prepared using the software. Then the quantitative data was entered into the database. Data quality was checked for completeness and consistency by running frequency and descriptive statistics.

After the quality check, descriptive statistics were carried out to determine the relative frequencies of all the survey variables using SPSS version 20. Appropriate graphs and tables were generated to show differences in the relative frequencies of various variables. Levels of association between various variables were determined by the Pearson X^2 test in situations where the expected frequencies were less than five. Where appropriate, values and confidence intervals (CI) for odds ratios (OR) were shown. The data were fitted with the Bivariate and multiple logistic regression models to estimate the predictors' of malaria transmissions. Crude OR and Adjusted OR were calculated. *P* values less than 0.05 were taken as statistically significant.

Ethical considerations

Ethical clearance was obtained from the institutional review board of the University of Gondar. Then, the Ethical Committee of Amhara Regional Health Bureau (ARHB) was informed to get further permission. Local administrations were also informed for permission and facilitation of the study. During data collection, informed consent was sought from all the study participants and they were informed and assured that interviews and blood tests were completely voluntary, all data were confidential, and that their names were linked to the data in any way. They were told that questions could be skipped or the interview could be stopped if they feel uncomfortable at any point. Participants were not compensated for their participation but those who were found positive for malaria parasite have given malaria treatment based on the national malaria guideline by a health facility nearby. Care was taken not to link collected information to the respondents by name. Data and information collected or analyzed were held confidential using code numbers for each completed questionnaire.

Results

Socio-demographic characteristics of seasonal migrant workers

A total of 1208 seasonal migrant workers were interviewed at departure sites from farm activities. Their mean age was 26.6± 5.4 and 27 medians (IQR= 8). The majority (99.4%) of the seasonal migrant farmworkers were male and 53.5% were in the age range of 25-34. Of the study subjects, 39.7% were able to read and write, 59.2% were farmers and 63.9% were not married. Dominantly, 97.9% were Amhara by ethnicity and 95.7% were Orthodox by religion (**Table 1**).

Table 1: Socio-demographic characteristics of seasonal farmworkers at departure phase in Metema district, Northwest Ethiopia, November 25-December 10,2018(n=1208).

Variables	Frequency (%)
Sex	
Male	1201(99.4)
Female	7(0.6)
Age (in years)	

15-24	453(37.5)
25-34	646(53.5)
35+	109(9.0)
Education	
Illiterate	411(34.0)
Read and write only	479(39.7)
Elementary	110(9.1)
Secondary and above	208(17.2)
Occupation	
Farmer	716(59.2)
Daily laborer	350(29.0)
Student	142(11.8)
Marital status	
Single	772(63.9)
Married	397(32.9)
Divorced	39(3.2)
Religion	
Orthodox	1156(95.7)
Muslim	38(3.1)
Others	14(1.2)
Ethnicity	
Amhara	1183(97.9)
Others	25(2.1)

Prevalence of malaria

The prevalence of Malaria at departure was 17.5% (15.6-19.45%). The relative Plasmodium species of positive cases were 71.80 % (177/212) *Plasmodium falciparum* and 28.20% (35/212) *Plasmodium vivax*. There was no mixed infection identified (**Figure 2**).

Travel history

The majority 935(77.4%) of the migrants were from rural residences. About 660(54.6%) were from highland which followed by low land 310(25.7%) (**Table 2**). Most 537(44.5%) of the migrants have visited one farm area whereas 379(31.4%), 229(19.0%), and 63(5.1%) of the study subjects were visited two, three, and four and above farm sites during their stay for farm activities. At the departure phase, most of the migrants were staying outside the shelter from 6:00 PM up to midnight. Nearly all 1203(99.6%) of study subjects have come from within the Amhara region and back to these areas (**Figure 3**). Of these, 604 (49.4%) were from the Central Gondar zone, followed by West Gondar 199 (16.5%), North Gondar 193 (16.0%), and South Gondar 149 (12.3%). About 771(64%) of the study participants were from Dembia (23.4%) and Chilga (19.5%) woredas in the Central Gondar zone and Metema (14.6%) woreda in West Gondar zone and Dabat woreda (6.4%) in North Gondar zone. Asymptomatic malaria distribution by their districts has shown most of the seasonal migrant farmworkers upon return to Dembiya(46), Chilga(42), and Metema(28) accounted for about 116 (54.7%) (**Figure 4**).

The number of asymptomatic malaria cases was associated with the period stayed at farm sites(X^2=322.8, P value=0.0001). The majority of the seasonal migrant workers with asymptomatic malaria cases, 100(8.3%) stayed at farm sites for two months, 31-60 days, and 88(7.3%) of the cases were stayed at farm sites for three months, 61-90 days (**Table 2**).

Table 2. Travel history of seasonal migrant workers at departure phase, Metema district, Northwest Ethiopia, November 25-December 10, 2018 (n=1208).

Variables	N (%)	Asymptomatic malaria		X^2	P-value
		Positive	Negative		
Residence					
Rural	935(77.4)	175(14.5%)	760(62.9%)	3.893	0.048
Urban	273(22.6)	37(3.1%)	236(19.5%)		
Origin/homeland					
High land	660(54.6)	143(11.8%)	517(42.8%)	24.675	0.0001
Mid land	238(19.7)	42(3.5%)	196(16.2%)		
Low land	310(25.7)	27(2.2%)	283(23.4%)		
Time stayed outside the shelter					
6:00PM-8:00PM	250(20.7%)	59(4.9%)	191(15.8%)	9.63	0.022
9:00PM-10:00PM	465(38.5%)	67(5.5%)	398(32.9%)		
11:00PM-12:00PM	418(34.6%)	74(6.1%)	344(28.5%)		
$\geq$ 1:00AM	75(6.2%)	12(1.0%)	63(5.2%)		
Number of farm sites visited					
One	537(44.5%)	68(5.6%)	469(38.8%)	21.489	0.0001
Two	379(31.4%)	70(5.8%)	309(25.6%)		
Three	229(19.0%)	57(4.7%)	172(14.2%)		
Four and above	63(5.1%)	17(1.4%)	46(3.8%)		
Days stayed at farm sites					
$\leq$ 30	63(5.2%)	6(0.5%)	57(4.7%)	322.8	0.0001
31-60	733(60.7%)	100(8.3%)	633(52.6%)		
61-90	350(28.9%)	88(7.3%)	262(21.5%)		
$\leq$ 91	62(5.2%)	18(1.5%)	44(3.7%)		

The practice of malaria prevention methods

The practice of malaria prevention and control methods were assessed at departure. Accordingly, About 87.3% of respondents had no LLINs and only 12.7% of the seasonal migrants at departure had LLINs. Of 154 seasonal migrants, the majority (55.2%) were using LLINs daily, and 69(44%0 were using LLINs sometimes. LLINs were used by 101(65.6%) in the last night at departure. Very few, 34(2.8%) of the study subjects used repellents at the study site (**Table 3**).

Table 3: Practice of malaria prevention methods among seasonal migrant workers at Metema district, Northwest Ethiopia, November 25 – December 10, 2018 (n=1208).

Characteristics	Microscope test		Total (%)
	Positive (%)	Negative (%)	
Ownership of LLINs			
Yes	27(2.2%)	127(10.5%)	154(12.7%)
No	185(15.3%)	869(72.1%)	1054(87.3%)
Frequency of using LLINs			
Daily	5(3.2%)	80(51.9%)	85(55.2%)
Sometimes	22(14.3%)	47(30.5%)	69(44.8%)
Use of LLINs in the last night			
Yes	10(6.5%)	91(59.1%)	101(65.6%)
No	17(11.0%)	36(23.4%)	53(34.4%)
Use of repellents			
Yes	6(0.5%)	28(2.3%)	34(2.8%)
No	206(17.1%)	968(80.1%)	1118(97.2%)
Wearing of long sleeve cloths			
Yes	30(2.5%)	168(13.9%)	198(16.4%)
No	182(15.1%)	828(68.5%)	1010(83.6%)
Smoking			
Yes	9(0.7%)	66(5.5%)	75(6.2%)
No	203(16.8%)	930(77.0%)	1133(93.7%)

Risk factors

Univariate analysis indicated that age, occupation, marital status, residence, origin/homeland, time to stay outside the shelter, number of farm sites visited and use of LLINs were significantly associated with malaria (**Table 4**).

Multivariable analysis revealed that age, occupation, origin, number of farm sites being visited, and utilization of LLINs were significantly associated with the risk of malaria infection ($P<0.05$). The prevalence of malaria was not significantly associated with education, residence, ownership of LLINs, repellent, wearing long sleeve clothes, and smoking ($P>0.05$, **Table 4**).

Study subjects in the age group of 25-34 (AOR =0.551, 95%CI 0.378-0.804) were less likely to have malaria infection compared with the age group from 18-24 years. Similarly, the risk of malaria infection (AOR =0.338, 95%CI 0.251-0.530) was lower among study subjects from low land areas compared to study subjects from high land areas. Malaria prevalence was significantly higher among daily laborers (AOR =1.497, 95%CI 1.065-2.105) compared to farmers. On the other hand, seasonal migrant workers who had visited two farm areas (AOR =1.588, 95%CI 1.085-2.324), three farm sites (AOR =2.421, 95%CI 1.558-3.761), and four and more farm sites (AOR =3.164, 95% CI 1.640-6.106) were significantly associated with malaria infection compared to migrants who visited only one farm site during their harvest time at destination. The finding had shown that as the number of visits to farm sites increased the risk of malaria infection was increased. Sometimes utilization of LLINs is about seven times likely to risk migrants for asymptomatic malaria infection (AOR=6.80, 95%CI 1.75-26.52) compared to migrants who used LLINs daily (**Table 4**).

Table 4, Predictors of asymptomatic malaria, Metema district, Northwest Ethiopia, November 25 – December 10, 2018 (n=1208).

	Malaria cases					
Variables	**Yes**	**No**	**COR**	**95% CI**	**AOR**	**95% CI**
Age (in years)						
18-24	94	359	1		1	
25-34	100	546	0.57	0.42-0.79	0.55	0.38-0.80
35+	18	91	0.49	0.27-0.90	0.65	0.32-1.30
Education						
No education	165	725	1			
Formal education	47	271	0.97	0.69-1.37		
Occupation						
Farmer	120	594	1		1	
Daily laborer	76	274	1.41	1.02-1.94	1.49	1.06-2.10
Student	16	128	0.88	0.53-1.45	0.74	0.43-1.25
Residence						
Rural	173	762	1		1	
Urban	39	234	0.68	0.46-0.99	0.75	0.50-1.12
Origin/homeland						
Highland	128	532	1		1	
Midland	47	262	0.77	0.53-1.13	0.96	0.64-1.44
Lowland	37	201	0.34	0.22-0.53	0.34	0.25-0.53
Number of farm sites visited						
One	57	480	1		1	
Two	77	302	1.56	1.08-2.25	1.58	1.08-2.32

Three	57	172	2.28	1.54-3.38	2.42	1.56-3.76
Four and above	21	42	2.55	1.38-4.69	3.16	1.64-6.11
Ownership of LLINs						
Yes	27	127	1			
No	185	869	1	0.64-1.56		
Utilization frequency of LLINs						
Daily	5	80	1		1	
Sometimes	22	47	7.48	2.66-21.09	6.8	1.75-26.52
LLINs used in the last night						
Yes	10	91	1		1	
No	17	36	4.29	1.798-10.27	1.14	.35-3.69
Repellent						
Yes	6	28	1			
No	206	968	0.99	0.41-1.24		
Wearing long-sleeve cloths						
Yes	30	168	1			
No	182	828	1.23	0.81-1.87		
Smoking						
Yes	9	66	1		1	
No	203	930	1.6	0.79-3.27	2.28	0.26-20.19

Discussion

This study characterized the role of seasonal migrant workers in carrying malaria with them while they were returning home. In this respect, asymptomatic malaria prevalence and risk factors were identified among seasonal migrant workers at the departure phase. Accordingly**,** asymptomatic malaria prevalence was identified and multivariable logistic regression analysis revealed that age, occupation, origin, number of farm sites being visited, and utilization frequency of LLINs were significantly associated with asymptomatic malaria prevalence risk of malaria infection.

In this study, a significant amount of asymptomatic malaria infection was identified among seasonal migrant workers at departure. The result identified that the prevalence of asymptomatic malaria cases was 17.5% (Table 2) with a high proportion of *Plasmodium falciparum* (71.8%). It was in line with the study conducted in West Armachio district of Northwest Ethiopia and Dilla town in South Ethiopia [43, 44] and India [45]and lower than the study conducted in East Shewa zone, Oromia, Ethiopia [46, 47], Nigeria[48], Tanzania[49], India [50] and China-Myanmar border, Southeast Asia [51] and higher than the study conducted in Gondar Zuria district of

Northcentral Ethiopia and Democratic Republic of Congo [52, 53]. The possible reason for the high prevalence of asymptomatic malaria might be due to significant proportion of seasonal migrant farm workers who had repeated malaria exposure due to frequent visits of the farm areas in the previous year or those who came from malaria-endemic areas for harvesting that would facilitate to develop partial immunity and then to carry the parasite for long periods without showing clinical sign and symptoms [54-56]. Asymptomatic malaria cases might be responsible to spread malaria in areas where they are passing through while they are returning home and their communities. The study conducted in villages around Lake Tana, Northwest Ethiopia indicated that travel to farms in the lowlands was significantly associated with the risk of malaria infection and imported malaria (91.5%) to the villages[8]. Moreover, the possible reasons for the difference could be differences in study design, geographical location, nature of study population, sample size, tool used, study period, and the implemented malaria control program in the study area.

In this study, age is considered one of the most important factors associated with asymptomatic malaria infection at departure [57]. Age groups from 25 -34 were protective for asymptomatic malaria infection compared with the age group from 16-24. This was in agreement with the studies conducted in Ethiopia[53] and Yemen where adults were predominantly asymptomatic malaria carriers compared to children[58]. The reference age group is more at risk of malaria infection compared to adults who are asymptomatic parasite carriers because they have acquired strong immunity from repeated exposures to the malaria parasite. Moreover, high exposure in farm areas, visiting various farm sites, and less use of preventive methods put this age group more at risk of malaria in the study area.

In this study, occupation was significantly associated with a high risk of malaria infection. Being daily laborers (individuals who work for daily wages) was at increased risk of asymptomatic malaria infection compared to farmers (persons whose farming is the main source of income). This might be due to high exposure to malaria infection that might be related to low income[59], less access to malaria information[8], behavior[43], less access to malaria prevention methods[26, 60], and having no access to health care[26]. According to the study conducted in Dembiya district, Northcentral Ethiopia, low malaria information was responsible for high malaria prevalence among study subjects who had travel history to low land malarious areas[8]. However, there was no significant association of malaria prevalence with students.

This study revealed a majority of the seasonal migrants' farmworkers were from the rural residence of high land areas and low land areas. The risk of malaria infection is high among migrants from highland areas due to low immunity to malaria. This might be the reason for the high malaria prevalence in this study group at departure. This was in agreement with the study conducted in West Armachiho district, Northwest Ethiopia [43]. There was evidence that travelers from high land areas to low land areas for farm activities were responsible for the spread of malaria to high land areas[55].

In this study, the number of farm sites being visited by study subjects was associated with the risk of asymptomatic malaria at departure. It was found that as the number of farm sites being visited was increased the risk of asymptomatic malaria was increased (Table 4). Seasonal migrant workers who had visited two, three, and four and above were significantly associated with the prevalence of asymptomatic malaria compared to seasonal migrant workers who had visited one farm site during their harvest time at development corridors. Visits of three and four farm sites were more than two and three times at risk of asymptomatic malaria infection compared to having one farm site visit.

In the current study, the ownership of LLINs was low among the study subjects. Only 12.7% of them possessed LLINs. LLIN ownership was lower compared with other studies in the area showing 32.4%in 2014[24], 64% in 2015 national MIS[61], and 31% in 2016[62]. Moreover, the ownership was also lower than the study findings from Cambodia[63]. Of the total 154 (12.7%) seasonal migrant workers who owned LLINs, 85(55.2%) were using LLINs daily. LLINs utilization was similar to the study conducted among seasonal migrant workers in Myanmar[64]. However, higher compared with the study conducted in Ethiopia showing 29% in 2019[65]. The study finding also revealed that about 66% of those who owned LLINs slept under LLINs the previous night. This finding was higher compared with the study conducted in Myanmar showing 50% among seasonal migrants[64]. This might be associated with low access to LLINs and most of the seasonal migrant workers did not bring their LLINs from home to farm areas.

This study kept its strength by taking increased samples and sampling techniques to minimize selection bias and to ensure internal and external validity. Confounding factors were also contained using Binary Logistic Regression analysis. Asymptomatic malaria prevalence and associated risk factors were investigated to determine the role of seasonal migrant workers in transporting malaria parasites to their origin upon return and the risk of spreading and challenging malaria prevention and control activities as well elimination goals in the country. Failed to use molecular tool PCR in detecting asymptomatic malaria to support microscopic investigation was the limitation of this study.

Conclusion

This study highlights high asymptomatic malaria prevalence among seasonal migrant workers departure/upon return migration phase. The role of seasonal migrant workers to carry and spread malaria parasites and challenging the country's malaria prevention and elimination activities could be immense. Age, occupation, origin, number of farm sites being visited, and utilization frequency of LLINs were significantly associated with an increased asymptomatic malaria prevalence in the study area. More is still needed to work on practice malaria prevention and control methods.

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Authors' contributions

TT, KA designed the study. TT, BT, KA implemented the study. TT, KA interpreted the data. TT wrote the first draft of the manuscript. TT, BT, KA critically revised the manuscript for important content. All authors read and approved the final manuscript.

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Availability of data and materials

Data and all the necessary materials are available with the corresponding author upon the request

Ethical approval and consent to participants

Ethical clearance was obtained from the institutional review board of the University of Gondar. Then, the Ethical Committee of Amhara Regional Health Bureau (ARHB) was approached to get further permission. Local administrations were also informed for permission and facilitation of the study. During data collection, informed consent was sought from all the study participants and they were informed and assured that interviews and blood tests were completely voluntary. Malaria cases were treated according to the national malaria guidelines.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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Figures

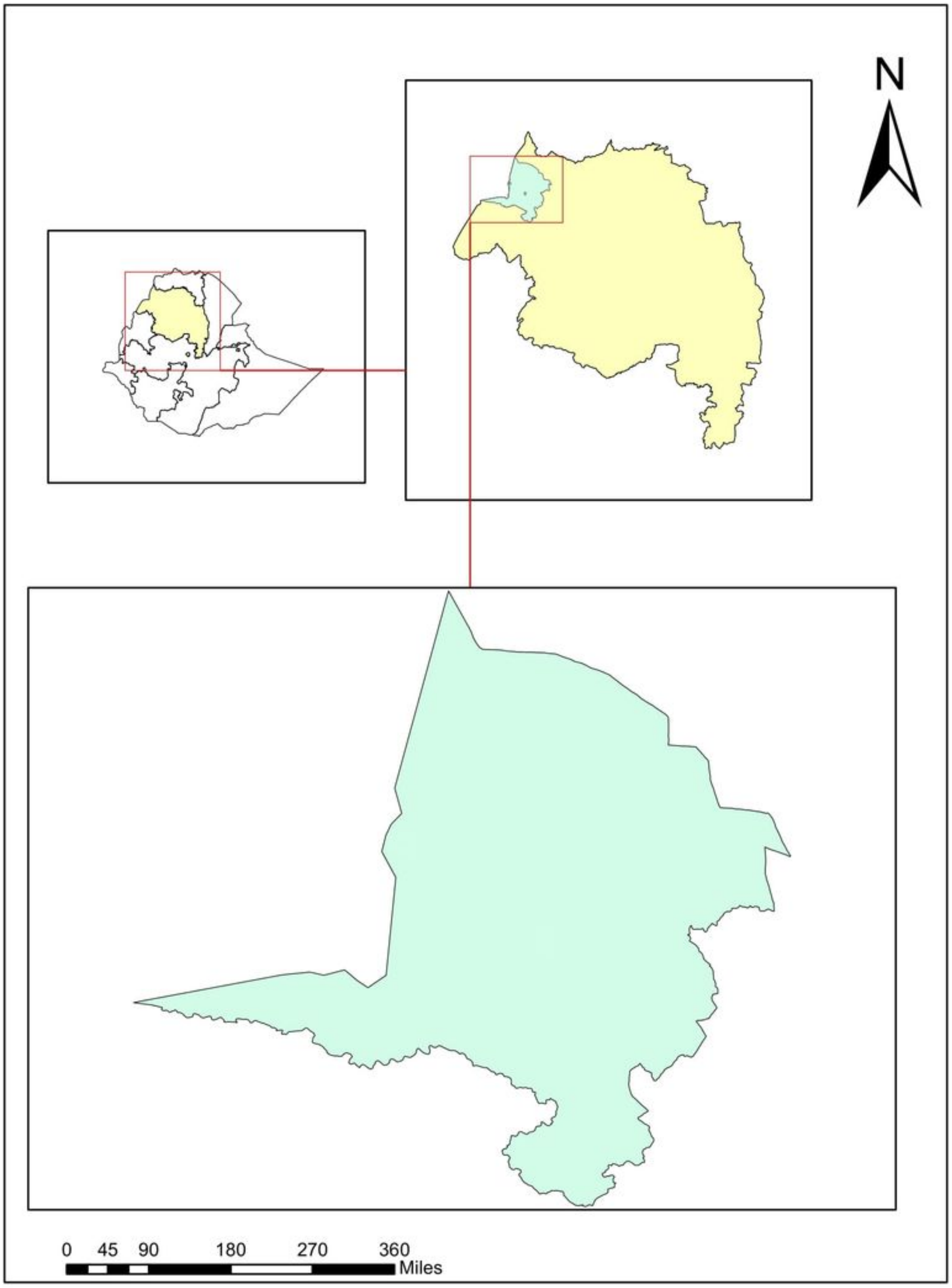

Figure 1

Map of Metema district, Northwest Ethiopia

Figure 2: Malaria prevalence among seasonal farm workers at departure phase in the Metema district, Northwest Ethiopia, November 25-December 10, 2018

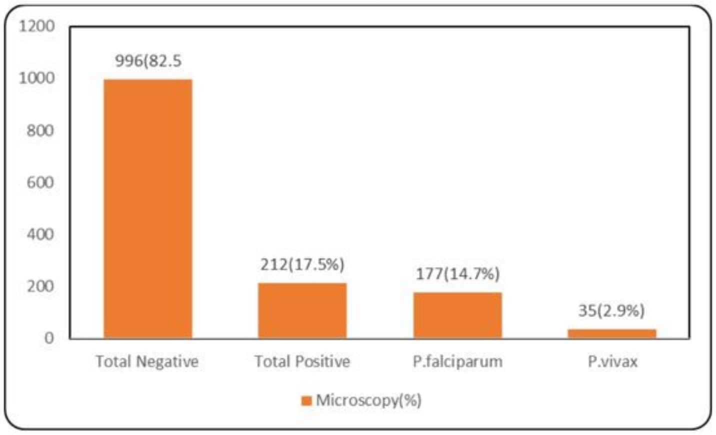

Figure 2

Malaria prevalence among seasonal farm workers at departure phase in the Metema district, Northwest Ethiopia, November 25-December 10, 2018

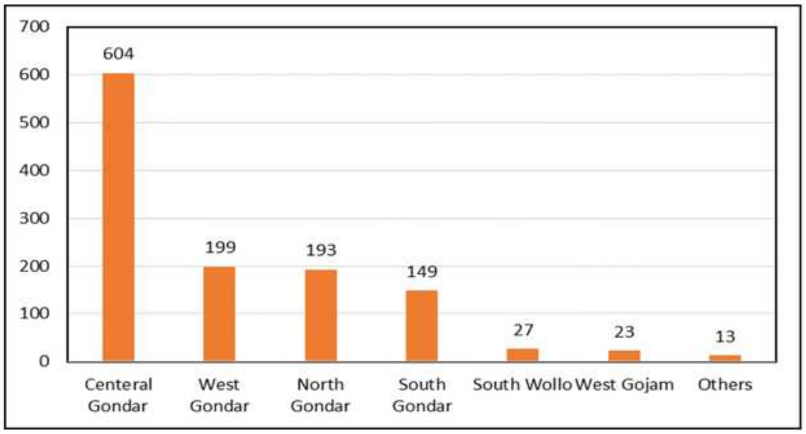

Figure 3, Study participants distribution by zones, Metema district, Northwest Ethiopia

Figure 3

Study participants distribution by zones, Metema district, Northwest Ethiopia

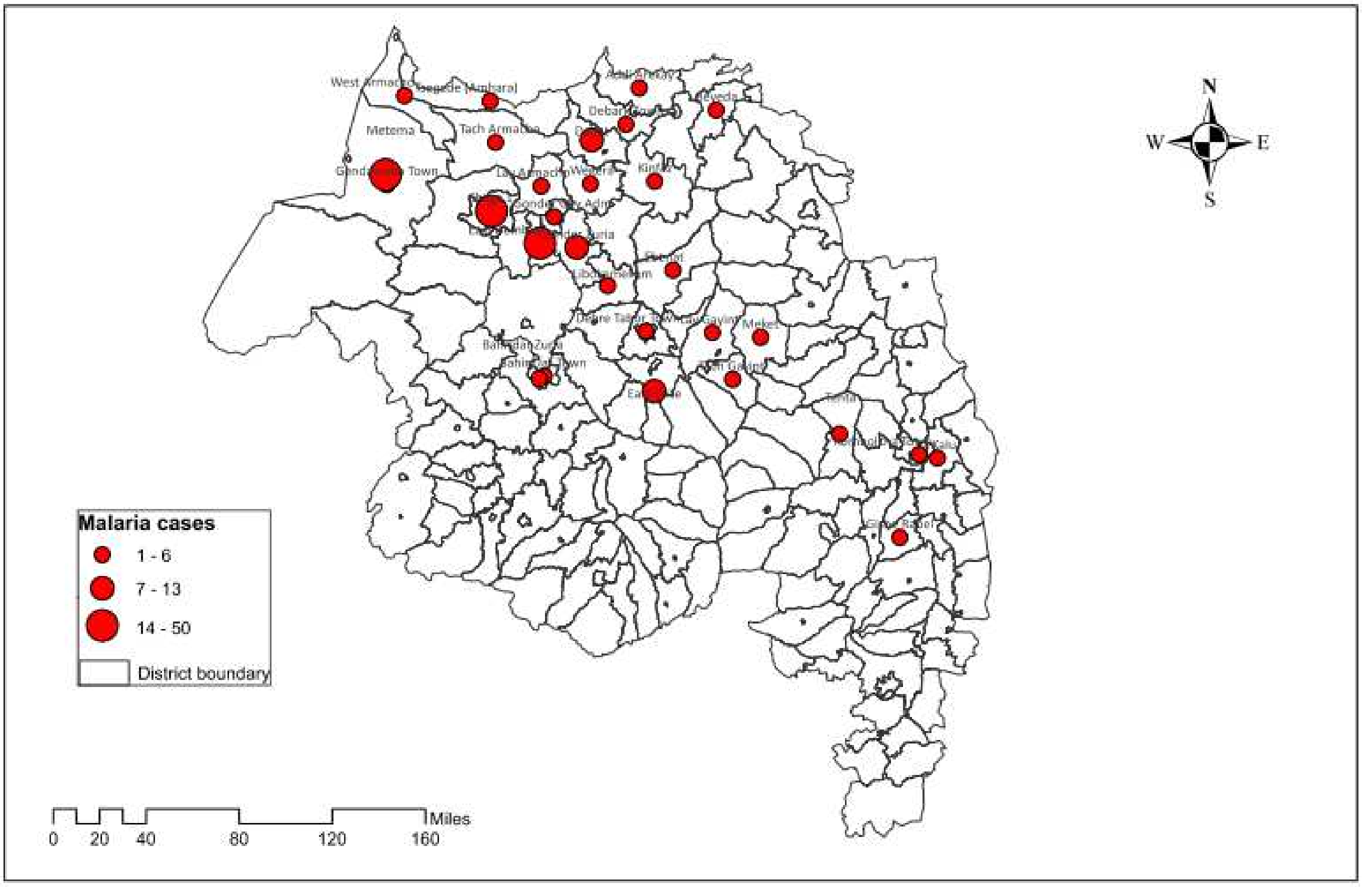

Figure 4: Asymptomatic malaria case distribution by origin/district, Metema district, Northwest Ethiopia

Figure 4

Asymptomatic malaria case distribution by their origin/district, Metema district, Northwest Ethiopia